Dryden Flight Research Center
Edwards, California 93523-0273

DHB-S-003
Baseline

Dryden Handbook

CODE S

BASIC OPERATIONS MANUAL (BOM) BACKGROUND AND GUIDANCE

Electronically Approved By:
Chief, Office of Safety and Mission Assurance

DOCUMENT HISTORY PAGE

This page if for informational purposes and does not need to be retained with the documents.

DATE APPROVED	ISSUE	PAGE	AMENDMENT DETAILS
See IDMS Document Master List	Baseline		

FOREWORD

This document, Background and Guidelines to the Dryden Basic Operations Manual (BOM) provides the Dryden implementation of these policies as they apply to flight operations carried out at Dryden. The policies govern the way we "do business" at Dryden, from the conception of a program through its development process and into its operational phase. Along with the 10 policies, this manual presents some guidelines to assist in implementing the policies. The material represents the results of an evolutionary process that is still at work. It must be understood that this manual is to provide direction for all actions and decisions pertaining to the Dryden flight research and test activities.

Due to the diverse nature of the programs conducted at Dryden, the policies have been written in a very generic sense. This allows each project to tailor its individual implementation of the policies, using the guidelines of this manual. Specific deviations need to be noted in the Operations Plan. This will help us achieve efficient operations without compromising safety.

It must also be understood that merely complying with the BOM policy does not relieve the individual from his most critical or important function, that of exercising common sense and good judgment--the safety of our operation must continue to be of paramount importance. Questions of conflict between a policy and the safest approach need to be resolved with senior management, even at the expense of a flight delay or cancellation. All employees must be constantly aware of the consequences of decisions or actions they might be called upon to take.

1.0 INTRODUCTION

POLICY

The Dryden Flight Research Center will conduct aircraft and access to space flight research to explore the unknown and to advance the state-of-the-art in atmospheric flight operations in the most efficient manner possible consistent with safe operating practices.

In order to conduct aircraft flight research in the most safe and efficient manner, effective operating procedures must be developed within a comprehensive risk management process.

This single statement sets the tone for all of the policies contained in this manual. Elements of safety and risk management are dealt with very specifically in certain sections, and an awareness of the importance of these elements pervades the entire document from cover to cover.

Essential to risk management and successful pursuit of the basic policy stated above is the implementation of effective procedures pursuant to actual accomplishment of the desired aircraft flight research. Direction must be given and guidelines established.

In some cases, experience has shown that there is a single, best way to perform some particular phase of a project. This will generally result in a firm policy or procedure being generated for the benefit of all future projects.

In other cases, several different approaches to a subject may be considered, each showing some distinct advantage over the others. These instances lead to the publishing of guidelines which will provide guidance along the most efficient and safe path, without requiring strict adherence to a rule that may unnecessarily restrict a project from doing what is deemed best for that particular situation.

In all cases, the policy or guideline is subject to change whenever new information leads to improvement. It is the responsibility of the Director of the Dryden Flight Research Center to develop, approve, change, and implement the policies contained in this manual

3.0 RISK MANAGEMENT

POLICY

A systematic and comprehensive risk management program will be integrated into each project to ensure that potential for injury to personnel or damage to property is at an acceptable level.

Dryden personnel involved with potentially hazardous operations will be trained and qualified to perform those duties in a safe manner so they present no danger to themselves, fellow workers, equipment, operating facilities, or the public.

Risk Management pervades the entire Basic Operations Manual. Because of this prominence, it is considered important to provide the reader with some guidance in this area. Terms associated with Risk Management are quality, safety, and reliability. This section addresses items that provide assistance to help individuals perform their work in the safest and most efficient manner possible. These items are also intended to provide assurance to project and senior management by means of visibility through the review process.

Flight activities and everyday ground operations involving aircraft at Dryden are subject to periodic reviews, from inception through completion. Many of these reviews specifically address safety, as distinguished from reviews of management, schedule, and resources. These reviews are addressed individually throughout this manual.

The Office of Safety and Mission Assurance monitors Safety, Reliability, and Quality Assurance on aircraft projects. This office, through active oversight, ensures that projects have applied the proper amounts of attention and resources to these functions.

Risks to a project's safe and efficient conduct and completion can, and will, be identified from the earliest conceptual phase of the project through the very end, or last flight. These risks may be identified through formal safety analyses, past experience, or through unexpected events that occur at anytime during the life of the project.

As these risks are identified, they will be assessed by the project team as to what their potential impact might be, what the chances of them occurring, and what can be done to eliminate, reduce, or control them. In some cases, the risk is reduced or controlled by redundancy or safety devices. In these cases the risk is considered eliminated, if a positive preflight test is used to prove prior to each flight that all redundant or safety devices are functionally operative. Some risks can not be eliminated due to project constraints, time, cost or practicality. These risks, if it is determined that the project will continue, then become "Accepted Risks" of that project.

Depending upon when these Accepted Risks are identified, they are to be presented to DFRC management at the earliest opportunity. This would normally be to the Airworthiness and Flight Safety Review Board or, after a project has entered the flight phase, at a Technical Briefing. Any risks that potentially endanger life or property must be made available for discussion at every Technical Briefing on an accepted risk list signed by the Project Manager. However, after acceptance by management, the lower level risks need not be presented further unless there is a change in their status.

Unpiloted vehicles, due to their probability of loss, have accepted risk levels that deviate from piloted aircraft.

It is DFRC management's responsibility to attend all Technical Briefings and to consider the impact of any and all accepted risks at this time. Satisfactory completion of the Technical Briefing is considered formal acceptance of the risk(s) presented by the project.
Some operations performed at Dryden could be hazardous to personnel and are a potential threat to valuable and often one-of-a-kind property. Hazards include toxic propellants, cryogenics, explosives, and high-pressure systems to mention just a few. Therefore, people who perform and control these potentially hazardous operations must possess the knowledge, skill, and judgment to do so safely. Nothing in this policy shall be used as justification for allowing hazardous duty payments or premium pay. It has always been Dryden policy to make all operations adequately safe, even potentially hazardous testing.

There is a certification system, which is detailed in the OWI-TBD "Aircraft Maintenance and Safety Manual." This system identifies the training requirements, the certifying officials, frequency of recertification, etc. for these hazardous operations as well as the quality related skills. Certification is required for:

Emergency Response Team (Hazardous Materials)	Aircraft Tow
Laser-Xenon-PAPI	Cranes
Explosives (Weapons)	Hi-Ranger
MSBLS	Welders
Water Tunnel	Solderers
High Pressure Systems	Flt. Line AGE
Hazardous Materials	Forklifts
Hearing Conservation	NDI
Respiratory Protection	LOX/GOX

Certification of aircrew members is per "Flight Operations Manual." Certification of flight controllers and other control room personnel is not required. Flight controllers and other key (uniquely talented) control room personnel are considered to be individually qualified on a case by case basis by demonstrated skills and expertise. As in the original selection, consideration by the functional manager of these skills in naming a substitute is important.

Flight Controller qualification is determined by, and formally documented by the Chief, Flight Operations Directorate.

4.0 SAFETY

POLICY

Project/Line managers will conduct flight programs, projects, and operations in accordance with the Dryden Management System which incorporates sound engineering, system safety, and workplace safety principles to include: Safety and Quality Assurance planning; certification, qualification, and training of employees; the Aviation Safety Program; and their Configuration Management Plans.

Dryden personnel involved with potentially hazardous operations will be trained and qualified to perform those duties in a safe manner so they present no danger to themselves, fellow workers, equipment, operating facilities, or the public.

Project management shall apply and document a systematic approach to any flight project operation to provide for identification, reduction or control of risks or, if elimination or control is impractical, an explicit acceptance of the risks under suitable constraints.

The Dryden Flight Research Center will conduct a comprehensive Aviation Safety Program to achieve the goal of accident-free operation.

A System Safety Plan will be established for each flight project and flight-critical facility operating under the cognizance of the Dryden Flight Research Center. This plan will be addressed at the earliest DFRC program approval point, and will be continuously refined for each subsequent DFRC approval cycle throughout the life of the project.

Safety is the project's responsibility and the Safety and Mission Assurance (SMA) Office is an integral part of each flight project at Dryden. Its primary responsibility is to ensure that a strong flight safety program exists and that senior management has an independent assessment available for its use. The SMA Office roll in its flight safety program consists of:

1. Advising Project/Facility Managers on the inclusion of the proper elements in early planning (System Safety and Quality Assurance Plans).

2. Participation in project design reviews to ensure hazards and risks associated with a particular design have been identified and eliminated or controlled.

3. Participation in project flight and operational reviews to ensure the completeness of the risk assessment and acceptance process through the management approval to proceed.

4. Auditing of ongoing projects to ensure proper quality of end products and documentation of the process utilized.

Elements of the formalized program that must be considered and integrated into each project and flight-related facility activity are:

1. System Safety--Involves a systematic identification of hazards associated with aircraft, related subsystems, ground support equipment, and facilities directly supporting flight.

2. Reliability and Quality Assurance-- Primarily involves identification of failure modes and trends; verification of compliance with processes and procedures that cover aircraft, and facilities directly supporting flight, shops, laboratories, and support contractors.

3. Safety, Health and Environmental Office--Responsible for Occupational Health and Safety.

4. Occupational Health and Safety--Involves issues related to worker safety and health, hazardous materials and operations, disaster preparedness, and environmental concerns, such as air and water quality and hazardous waste disposal.

The term "System Safety" is defined as a formalized and documented use of selected analyses from a broad group of available studies to identify, eliminate, or control all hazards or risks that are present throughout the entire flight, facility, and ground combination that makes up the system.

The responsible Project Manager begins this process by addressing the classification of the project in conjunction with NPG 7120.5A and with the Safety and Mission Assurance Office. The results of this meeting will provide an outline for a System Safety Plan that identifies which analyses are to be performed, and which project milestones the analyses are intended to support. This plan is often part of a combined System Safety and Quality Assurance Plan. Early information regarding inherent hazards allows change, or hazard elimination, at minimum cost. During this and all subsequent phases, all hazards are to be logged, tracked, and formally resolved. Open hazards that cannot be resolved will be assessed for potential impact and will thereafter be presented as "accepted risks."

Project personnel should make sure that the Dryden "Aircraft Mishap Response Procedure" is adequate to their needs, or whether an Annex should be written for their particular requirements.

The responsibility for the Aviation Safety portion of the overall Flight Safety Program resides with a Dryden pilot assigned the collateral duties of Aviation Safety Officer (ASO). In addition to serving as a staff advisor to DFRC management on matters involving flight safety, he performs the following general duties:

a. Fosters an attitude and environment conducive to aviation safety among all assigned NASA/Government/Contractor pilots and other individuals involved in flight activities.

b. Acts as the focal point on all aviation safety matters:

(1) Acts in behalf of the Director of the DFRC and reports directly to the DFRC Chief Engineer when discharging this responsibility.

(2) Works in cooperation with the Dryden's Branch and Directorate Chiefs, Office of Safety and Mission Assurance, and the Director of Dryden, as necessary to promote flying safety.

(3) Maintains liaison with the Air Force Flight Test Center, contractors and operational units as appropriate, in order to ensure an exchange of safety information.

(4) Maintains liaison with ASOs at NASA Headquarters and other NASA aviation activities.

(5) Coordinates activities pertaining to airworthiness with the Operations Engineering Branch.

Due to the limited resources and complex nature of the many and varied DFRC research programs, the ASO cannot be fully versed in the safety implications of each technology or mission being flown. Therefore, the SMA Office assists, or totally performs, many of the tasks as outlined in NHB 7900.3 (V1).

The System Safety Plan is the project's proposal for implementing the formal aspects of hazard analysis and identification, the procedures to be used for the resulting risk assessment, and the elimination, control, or acceptance of the risk. It will include a designation of the scope, accountability, and any applicable milestones proposed for the project's safety program. This plan will be subject to the same approval process as the Project Plan, necessitating continuing acceptance and approval by the Planning Council.

The responsibility for developing and implementing the plan is assigned to the Project Manager. The plan, its implementation, and results of analyses are considered by a number of review boards as the project proceeds from the conceptual stage into the flight preparation stage; a final review is also made before the project is allowed to conduct a first flight or major operation. The first two reviews are normally the Preliminary Design Review and the Critical Design Review, where safety planning and results are reviewed as an integral part of the program.

5.0 REDUNDANCY/FAILURE CRITERIA

In line with Dryden policy of reducing risk to a level acceptable to management is the task faced by each project of attempting to surmise of what that level consists. If the following criteria are met, the project will normally not be found lacking at Flight Readiness/Airworthiness approval time.

Requirements for redundancy in new or modified systems at DFRC are related to ground/flight safety of flight vehicles only and have no bearing on Project level decisions made relative to unmanned vehicles or mission success in either case.

1. No single failure of or in a system can cause loss of the vehicle/aircrew. The single exception to this rule is in the case of critical structural members that can not be practically backed up with a redundant piece of structure or system. These must be designed with a factor of safety of 1.5 over the maximum intended design load, as with all structure.

2. For critical electronic hardware or software, no single failure can cause loss of operational capability ("fail-op"). No two failures can cause loss of the vehicle/aircrew ("fail-safe").

As a rule, a redundant system or inhibit against an undesirable event is considered nonexistent if it cannot be monitored in real-time in the control room and/or by the aircrew in the aircraft. An exception to this requirement is a system or component that is passive in its installed state and cannot be monitored for failure until it is asked to operate. An example of this type of system is a relief valve on a pressurized tank. In this case, the component must be capable of being tested for normal operation (in this example, relief at the proper pressure) during normal pre-flight activity.

The decision to continue a research flight with an electronic system failed to the "fail-op" mode must be made in advance by the project team and briefed at the Tech Briefing but in most cases will be considered cause to discontinue the flight and return to base.

Note:

Due to difference in Remotely Piloted Aircraft philosophy, unpiloted vehicles do not need to comply with this redundancy/failure criteria. However, some unpiloted vehicles such as the Pegasus rocket may have "piloted aircraft" criteria required of them while being carried on a piloted aircraft such as the B-52.

6.0 TREND ANALYSIS

The personal flight-by-flight attention given to experimental one-of-a-kind systems by the cognizant Dryden engineers and technicians provides for direct recognition of trends. Programs are required to provide a suitable alternative tracking system in order to accomplish the same end result.

With regard to the non-experimental aircraft systems operated by DFRC, the existing fleet-wide data banks of the military or commercial forces utilizing these aircraft, already provide for on-going trend analysis.

Dryden does become the beneficiary of this global activity, receiving corrective direction for adverse trends, in the form of service bulletins, technical orders, etc. Configuration changes to any DFRC aircraft shall be incorporated in accordance with the Configuration Management procedures.

7.0 QUALITY ASSURANCE AUDIT

Designated individuals from the SMA Office perform quality assurance/system safety audits throughout the year.

Quality assurance audits are performed on aircraft and associated shops and contractors to:

a) Identify where directives must be established, altered, or deleted to either adequately describe existing operations or to bring these operations into compliance with Agency or Center policies.

b) Assure that operations are being conducted by existing procedures and that quality assurance functions are being met.

c) Ensure accuracy and completeness of records reviewed.

Quality assurance audits are performed along the following guidelines:

a) A spot inspection is performed to verify work in progress is accurately reflected by the paperwork.

b) Paperwork/records are examined to verify an adequate paper trail from authorization to final inspection.

c) Records are examined for apparent abuse (such as wrong signatures, self inspection, illegal time extensions, etc.).

d) The work area is examined from an Occupational Safety and Health viewpoint.

8.0 PRE-ACCIDENT PLAN

Each government or contractor employee at Dryden is expected to know what to do when suddenly faced with an impending or actual aircraft emergency. In order to ensure that each person is prepared to react properly, a pre-accident plan has been prepared. The Dryden pre-accident plan is contained in the Aircraft Mishap Recovery Procedure. The pre-accident plan covers the lines of responsibility, expected responses, and the general information on ground and flight emergencies. A thorough understanding and familiarity with the contents of the plan will ensure that injuries to personnel and damage to equipment are avoided or minimized.

Individual Project Offices very often supplement this plan with more detailed plans of their own that specifically define responses that are expected of personnel involved with that particular project.

9.0 ENVIRONMENTAL IMPACT ANALYSIS

POLICY

Every flight project that involves the Dryden Flight Research Center will have environmental impact analysis documentation approved by the Planning Council before project implementation and any significant DFRC resources are expended.

The National Environmental Policy Act (NEPA) establishes the nation's policy and goals for protection and enhancement of the environment and contains provisions to ensure compliance by all Federal agencies. In addition to technical and economic factors, NEPA requires Dryden to consider the environmental consequences of a project during its planning phase.

Form DFRC 39 is the medium for initiating the environmental impact analysis process at Dryden. The Project manager completes section I of the form by describing the project and its purpose in sufficient detail that an evaluation of its total impact can be assessed. The form is then submitted to the Dryden Safety, Health and Environmental Office (Code SH) who will complete sections II and III to determine the required level of NEPA documentation for the project: Categorical Exclusion (CatEx); Environmental Assessment (EA); Environmental Impact Statement (EIS). An approximate level of effort for these types of documentation is as follows:

- CatEx - two weeks and performed by SH
- EA - six months and $100,000
- EIS - two years and $1,000,000

Code SH will complete CatEx documentation when appropriate and return it to the project Manager with applicable requirements for permits and/or mitigations of environmental impacts.

The CatEx will be included with the preliminary submittals to the Planning Council for review. If an EA or EIS is required, the Project Manager will arrange for completion of the documentation with Code SH providing consultation and review. The EA or EIS must be completed prior to the expenditure of significant resources to allow an informed decision regarding project implementation.

Form DFRC 39 will be resubmitted to Code SH and the Planning Council if there is significant change in the scope of the project which has the potential to impact the environment.

The CatEx will typically be the required level of NEPA documentation for standard projects utilizing local resources with low potential for environmental impact (i.e., CV-990 demonstration of STS tire system capability, F-16 modified wing for study of laminar flow characteristics). The EA may be prepared for projects with potential impacts outside the direct control of Dryden, but without the potential for significant effect on the environment (i.e., Pegasus Booster Rocket, Hyper-X Research Vehicle). The EIS is required for projects with potential to significantly impact the quality of the environment (i.e., Space Shuttle, X-33)

10.0 FLIGHT-CRITICAL FACILITIES

The NASA Western Aeronautical Test Range (WATR) consists of both fixed and mobile range facilities. The WATR is composed of equipment, personnel and procedures necessary to support NASA's Aeronautics and Space Transportation Technology Enterprise, Earth Sciences Enterprise, and Human Exploration and Development of Space Enterprise. Facilities consist of space positioning systems, telemetry tracking stations, communications systems, video systems, real-time processing and display systems, post flight data processing and archival systems, and mobile systems. The WATR complex is centered on the third floor of Building 4800 with remote sites on Edwards Air Force Base.

With full command uplink and downlink capability, satellite and terrestrial communications links, the WATR can keep in real-time contact with flight research vehicles on many different ranges. Also, the WATR is an integral part of the worldwide tracking and communications ground network providing support to the space shuttle program as well as other low earth orbiting spacecraft.

11.0 CONFIGURATION MANAGEMENT

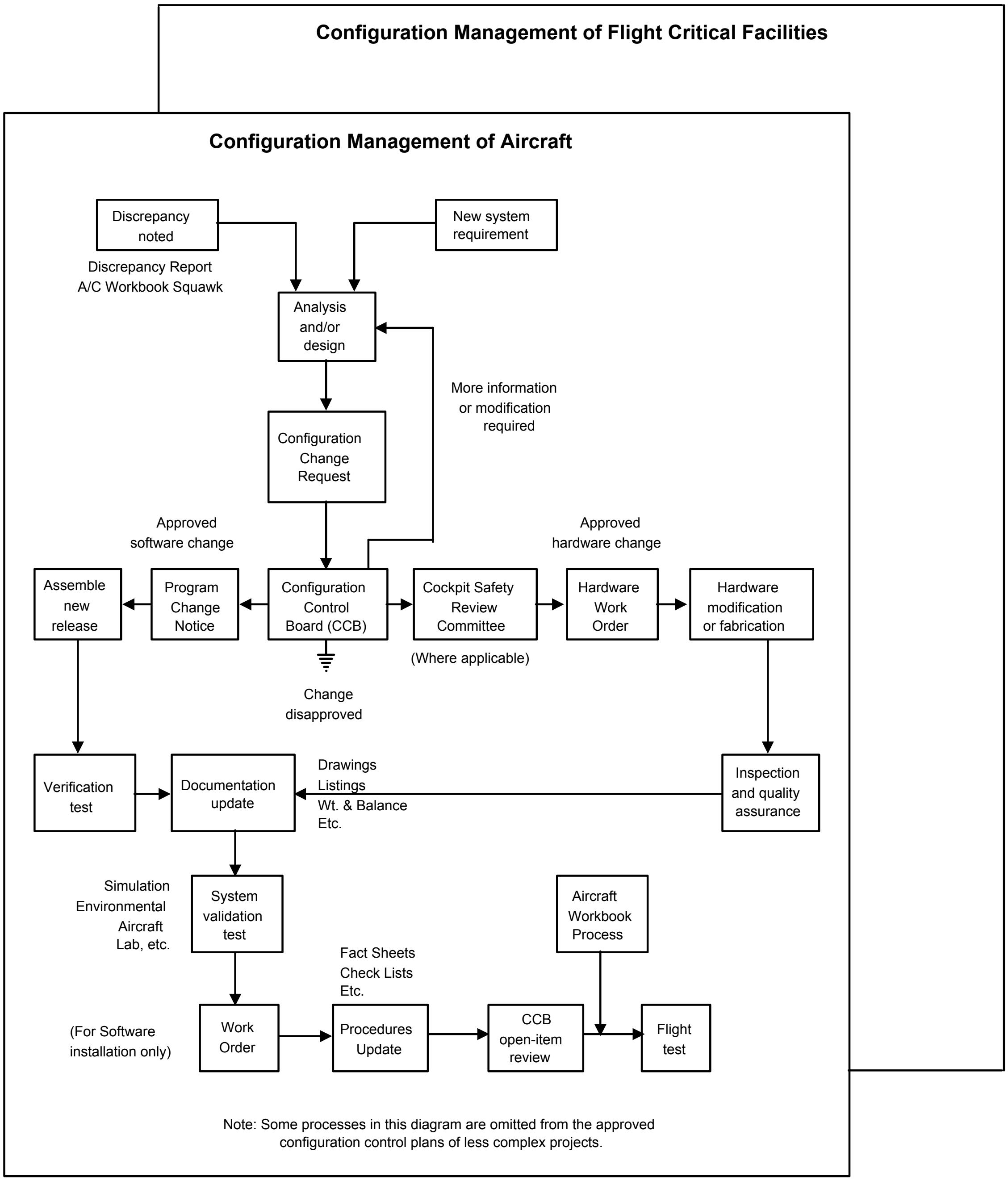
POLICY

All flight vehicles and flight critical systems and facilities under Dryden control will have configuration control. The extent of control for each system will be determined by the Project or Facility manager and documented in a Configuration management Plan.

The purpose of a formalized Configuration Management policy at Dryden is to ensure that flight projects and facilities supporting flight projects have a means of review and approval for changes to a baseline configuration. The Configuration Management system includes the change control process and reviews necessary to maintain and track the configuration control process.

The magnitude of the Configuration Control process depends upon the impact of changes regarding flight safety of the aircraft. The level of formalized control and processes utilized are to be determined by the project and formalized in the Project's Configuration Control Plan.

Facilities are responsible for the configuration control of their facility in support of flight projects.


Configuration Management of Flight Critical Facilities
Configuration Management of Aircraft
Discrepancy noted
New system requirement
Discrepancy Report
A/C Workbook Squawk
Analysis and/or design
More information or modification required
Configuration Change Request
Approved software change
Approved hardware change
Assemble new release
Program Change Notice
Configuration Control Board (CCB)
Cockpit Safety Review Committee
Hardware Work Order
Hardware modification or fabrication
(Where applicable)
Change disapproved
Verification test
Documentation update
Drawings
Listings
Wt. & Balance
Etc.
Inspection and quality assurance
Simulation
Environmental
Aircraft
Lab, etc.
System validation test
Aircraft Workbook Process
Fact Sheets
Check Lists
Etc.
(For Software installation only)
Work Order
Procedures Update
CCB open-item review
Flight test
Note: Some processes in this diagram are omitted from the approved configuration control plans of less complex projects.

12.0 COCKPIT SAFETY REVIEW

POLICY

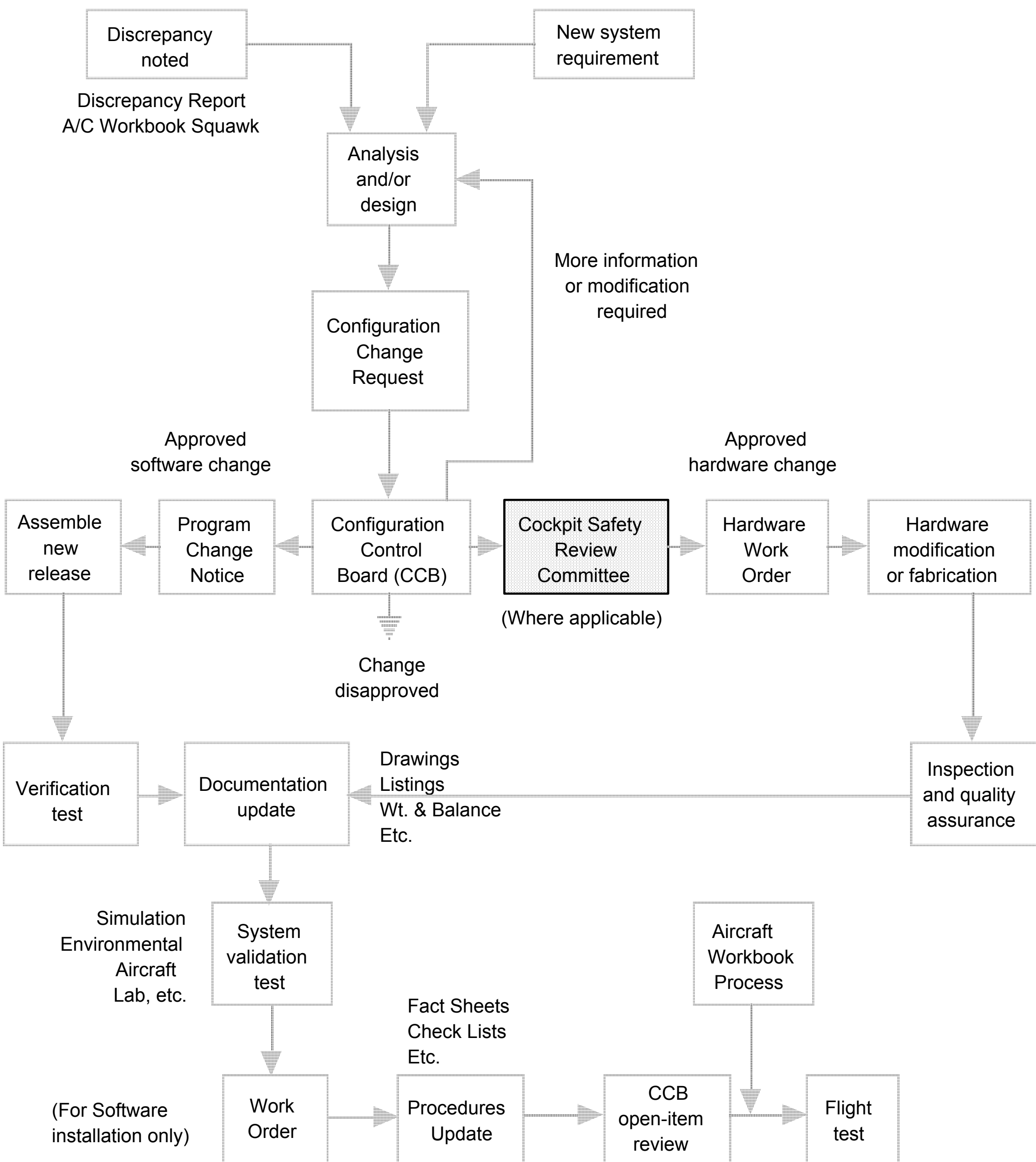
> All modifications to aircraft cockpits, which have potential impact on the operation of the life support systems, or on egress envelope clearances, shall be given prior independent review by the Cockpit Safety Review committee.

It is the responsibility of the Configuration Control Board to ensure that all available details of proposed cockpit modifications have been adequately reviewed by the Cockpit Safety Review Committee. The Cockpit Safety Review Committee reviews all modifications to Dryden aircraft cockpits that may have an impact on the life support systems, ejection envelopes, or normal ingress or egress. The committee is composed of the Aviation Safety Officer as Chairman, the Chief of the Life Support Section, and the Assistant Chief of the Flight Operations Directorate.

The reviews will normally include modifications to breathing oxygen systems, instrument panels, and ejection seats; the addition of equipment to consoles, canopies, or windshield assemblies, and all loose equipment (such as cameras and tape recorders). Any other modifications that could conceivably fall in this category will also be reviewed.

Any loose equipment to be carried aboard a Dryden aircraft must have the approval of the pilot in command before boarding the aircraft. In addition, any equipment other than a single 35mm still camera to be carried aboard an aircraft with ejection seats or capsules, or having space-limited cockpits, must be approved by the Cockpit Safety Review Committee. Where applicable, a list of pre-approved equipment will be maintained in the Aviation Safety Officer's office.

Configuration Management of Aircraft



Note: Some processes in this diagram are omitted from the approved configuration control plans of less complex projects.

13.0 WEIGHT AND BALANCE

POLICY

All Dryden controlled research flight vehicles will be weighed and balanced annually as a minimum.

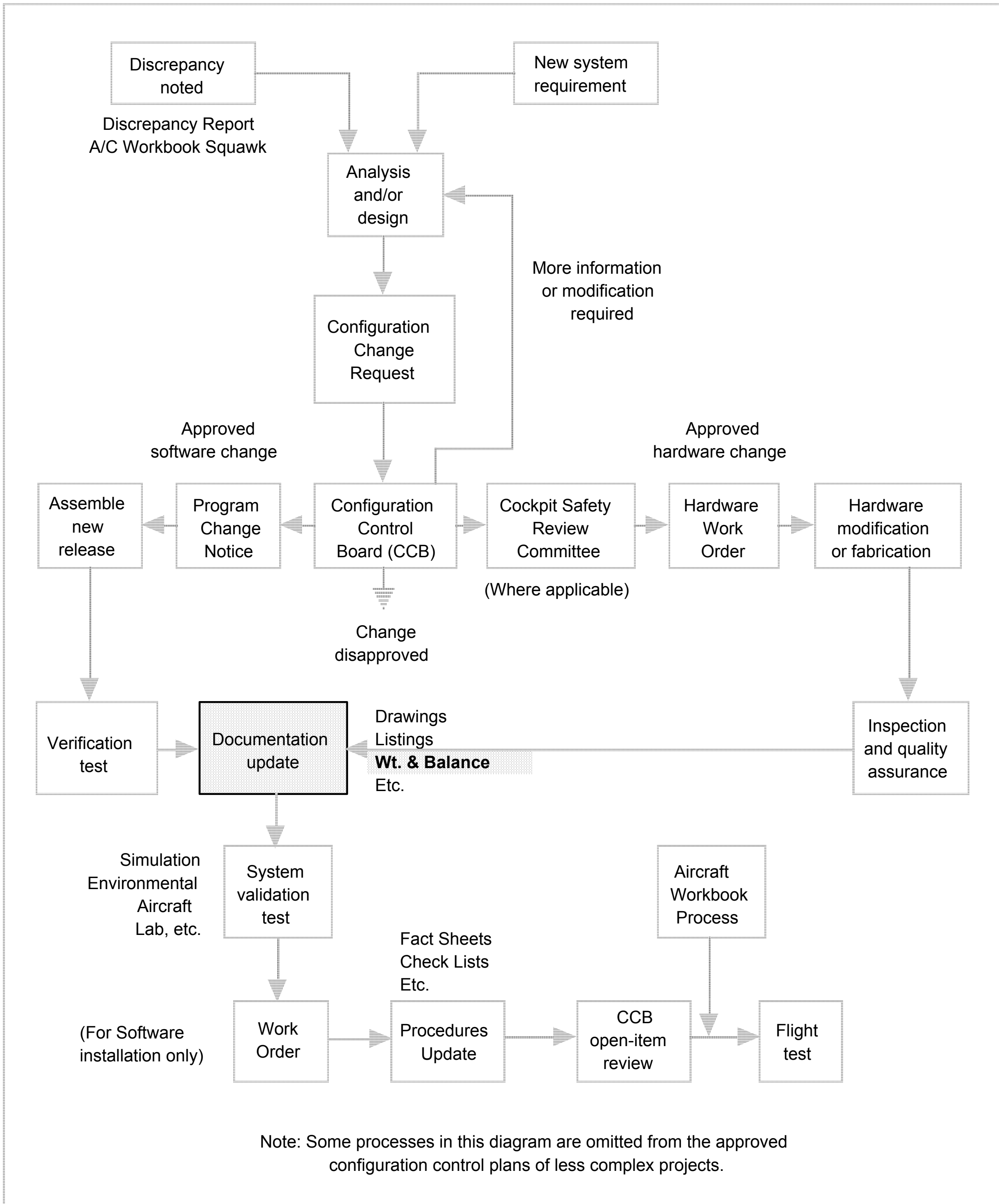
Aircraft in operation at Dryden will be weighed in accordance with Air Force Technical Order 1-1B-50, Paragraph 4-12. Aircraft will be weighed under the following conditions: When major modifications or repairs are made, when the pilot reports unsatisfactory flight characteristics, when the calculated weight and balance are suspect, before a first flight, and for research aircraft, within 12 months of any previous weighing. Between weighings, a log of aircraft weight and balance parameters, including center of gravity location, will be kept and updated as required by the Operations Engineer assigned to that program.

The weight and center of gravity location are extremely important aircraft parameters that must be known to ensure the safe and efficient operation of an aircraft, and to enable proper data reduction of the flight test information during and after a research flight.

An aircraft is weighed and its center of gravity is located using the Edwards Air Force Base Weight and Balance Facility. This facility has the capacity to accommodate any aircraft flown to date at Dryden, and any it may fly in the foreseeable future. In some cases Dryden facilities will be used in conjunction with, or in place of, the Edwards facility. This procedure is usually done in various configurations before the first flight of an aircraft, and at periodic intervals throughout the flight program. This is especially appropriate following major modifications to an existing aircraft.

Between the periodic weighings of the aircraft, it is the responsibility of the Operations Engineer to maintain and update a log of the removal, relocation, and addition of any parts, equipment, or fuel, and to calculate the resulting total weight and center of gravity. The complexity and historic accuracy of this process will determine how often an actual weight and balance procedure must be performed for any individual program.

Configuration Management of Aircraft



14.0 ENVIRONMENTAL QUALIFICATION

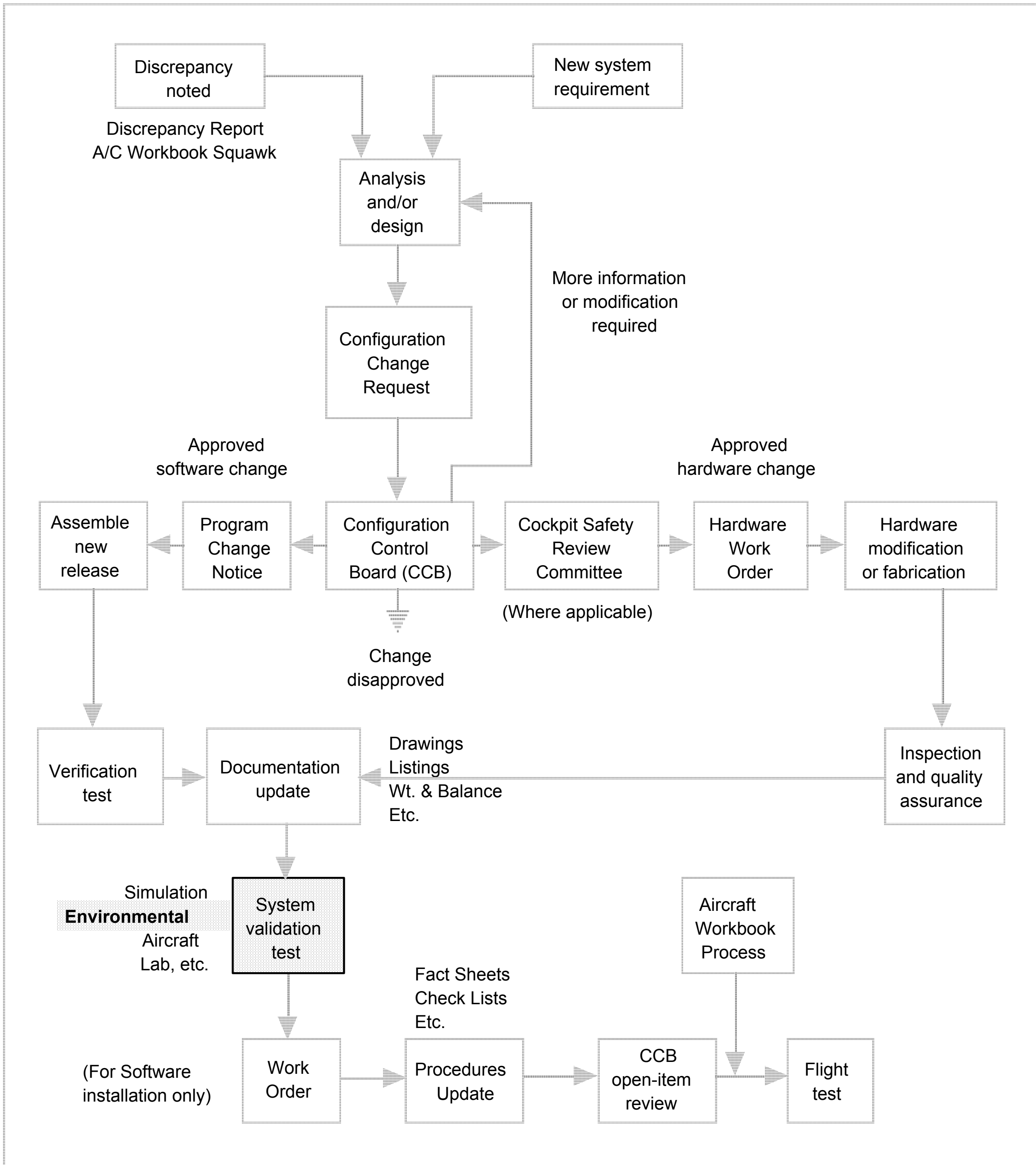
POLICY

All Dryden owned and Dryden customer supplied hardware to be installed on flight vehicles will be qualified to ensure the equipment will operate in the proposed working environment.

Ensuring the capability of end-item articles of hardware (particularly electronic or electromechanical) to perform adequately and reliably throughout the design specification environment is a good engineering practice. It is also a prime factor in the conduct of safe flight tests and research, as it allows concentration to the task at hand with less concern for component failure-induced emergencies.

Because of this, Dryden requires all hardware developed specifically for or adapted for use in a flight project operating under its cognizance to meet the qualifications as stated in the Dryden Process Specification System. It should be noted that it is <u>not</u> a requirement that this testing must be done at the Dryden Flight Research Center. Review of test data accomplished previously by the vendor or developer may reveal that the intent of the process has already been either fully or partially met. Testing needed to complete its qualification may be performed without retesting those portions previously completed.

Configuration Management of Aircraft



Note: Some processes in this diagram are omitted from the approved configuration control plans of less complex projects.

15.0 FLIGHT PLAN/REQUEST

POLICY
Flights conducted under the control of DFRC will have a documented flight clearance approving the flight operation between one and three days prior to flight.

The detailed planning of each flight is normally accomplished by the Project Pilot, who coordinates input from various disciplines involved with the program, ending up with a set of flight plans designed to accomplish the program objectives in a safe, rapid and orderly fashion. These individuals, along with the entire Project Team, must consider the Project objectives, the aircraft performance available, simulation results, and any other operational factors involved. The resulting flight plans are then used to prepare the flight cards, a written step-by-step description of the proposed flights. Each requested flight maneuver is placed in a proper sequence to assure an efficient use of the flight time available. Each test point to be performed during the flight of a research vehicle must be outlined in a Technical Briefing before the flight is flown.

16.0 PRE/POST-FLIGHT TESTING

Many tests take place on each of the projects conducted at Dryden. Some of these tests are performed once only, before the aircraft ever makes its first flight. Others occur as a normal part of the pre- and post-flight routines, and others are devised for a particular instance of troubleshooting. Since the tests are usually unique to a given project or flight vehicle, no attempt will be made here to detail the procedures normally used. Instead, we will briefly list and describe a few common tests to show the extent of the testing that may be part of each project.

Combined Systems Test (CST)--A CST is a test of the entire vehicle, its systems, instrumentation, and ground systems. This test is usually run through the control room (set up to function as it will during an actual flight), and is manned by the same project team members that will look at the data on flight day. The result is a total end-to-end check of the entire system before the vehicle is committed to flight.

Inertia Swing--This test provides a verification of the calculated or estimated moments of inertia of an aircraft; it is mostly performed on small, unique, special research vehicles.

Taxi Test--A taxi test is often performed on new or highly modified aircraft to verify ground handling and systems interactions before an aircraft is committed to a high-speed takeoff or landing. These tests are normally performed incrementally from a very low speed up to, where possible, the takeoff and landing speeds.

Captive Flight--With air-launched vehicles, one or more captive flights are usually performed where the aircraft is taken through a normal mission up to the actual point of launch from the carrier aircraft. This is similar to a Combined Systems Test, but performed in the actual environment that the aircraft would see climbing to the launch point.

Loads Test--Loads tests are often performed on parts of an aircraft that have been modified to verify the designer's calculations in a non-critical environment. These are normally conducted in our Flight Loads Laboratory.

Pre-Flight Functional Tests--These tests are part of the routine maintenance performed on every aircraft flown at Dryden, and vary with each project. They are normally developed by the Operations and Systems Engineers and are used to validate the proper performance of all the systems on the aircraft before flight.

17.0 INSPECTION SYSTEM

The Dryden Flight Research Center has a unique type of inspection system, consisting of a mix of Quality Inspectors and Designated Inspectors. Quality Inspectors assigned to the Flight Operations Directorate have responsibility for inspections on Dryden aircraft, support facilities, and special projects as assigned. They are frequently oriented toward the entire aircraft and its related systems.

The Designated Inspectors, also assigned to the Flight Operations and Facility Directorates, are technicians designated as inspectors with the authority to perform specified inspection functions on assigned aircraft, support equipment, and support facilities. These inspectors are more items oriented, and are limited in the areas they are authorized to inspect (such as individual items of the aircraft, and systems preflight inspections and functions).

18.0 AIRWORTHINESS AND FLIGHT SAFETY REVIEW

POLICY

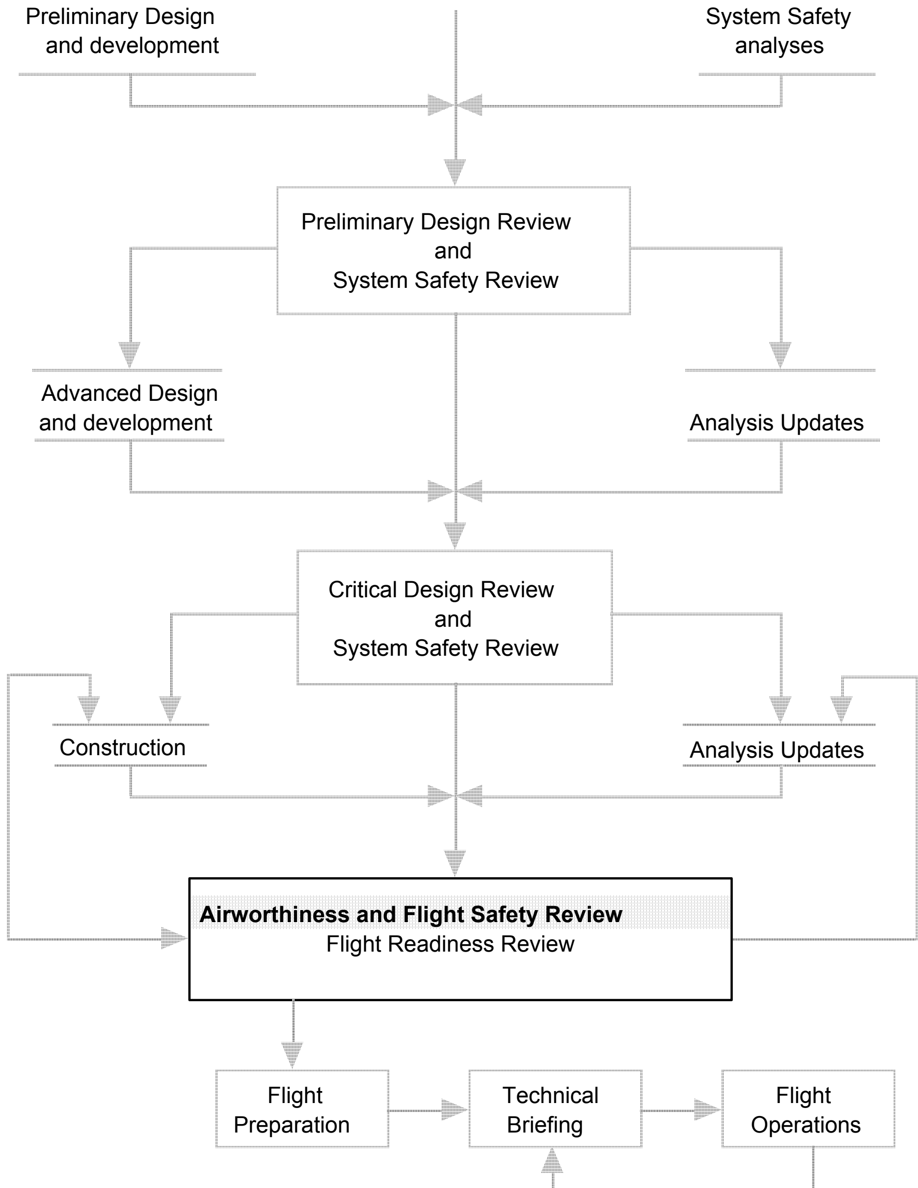
Requirements for airworthiness will be established at the Project Formulation Phase and will be implemented during the flight Preparation and Operation phases through:

- Planning Council reviews
- Cockpit Safety Review
- Flight Readiness Review
- Airworthiness Flight Safety Review Board Reviews
- Tech Briefs
- Mini Tech Briefs
- Environmental Impact Analyses
- System Safety Impact Analyses
- Hazardous Materials Impact Analyses

The Dryden Flight Research Center has established an Airworthiness and Flight Safety Review Board, chaired by the Chief Engineer, to carry out the process of this policy. The AFSRB has the overall responsibility to ensure a strong and viable flight safety program at Dryden, and to see that the formulation and implementation of Center policy is consistent for all flight activities managed by the Center. The Board has the responsibility to implement the review and reporting process established by DMI 7940-1 to ensure flight safety. The Board will review flight activities and tests involving all aircraft, critical flight systems, or experimental facilities involving Dryden.

The Chairman of the Board will review all flight activities and facility tests in an early phase to determine if a full Board review is necessary. Typical of reviews conducted by or for the AFSRB is the Flight Readiness Review, held prior to the first flight of a new or highly modified aircraft.

Review Cycle



19.0 FLIGHT READINESS REVIEW

(From DMI 7940-1):

> "The Board has the responsibility to ensure that Center line management provides sufficient second and third party reviews of all flight project activities that could affect airworthiness and flight safety…the Board reserves the right to appoint additional ad hoc committees or solicit expert advice from within or outside the Center…."

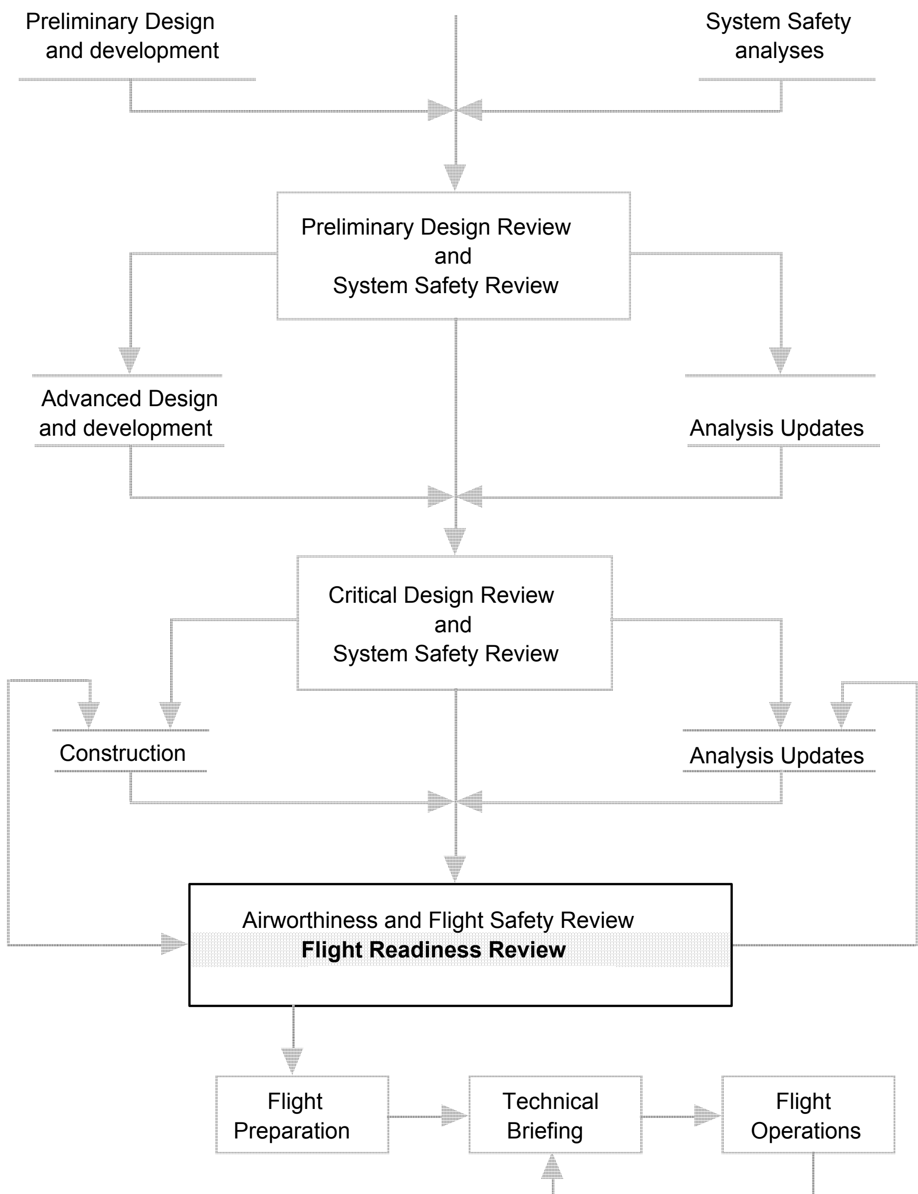
The Airworthiness and Flight Safety Review Board will require a Flight Readiness Review (FRR) to be conducted before the first flight of a new or extensively modified vehicle, or of a new operation different from the design mission of an existing vehicle. The FRR is a thorough investigative evaluation of the airworthiness of a vehicle and the Project Team's plans to perform the program for which they are being readied. The review will be performed by an ad hoc committee with members selected for pertinent skills and background, but not assigned to the project.

The FRR Committee will be expected to perform any and all required evaluations of the program or operation, including the design, fabrication, performance and software. Part of this evaluation is the review of substantiating data gathered as the result of wind tunnel testing, ground testing, and simulation. The plans and results of any safety analyses are to be reviewed and evaluated by the FRR Committee.

The FRR Committee will usually present a report, both orally and in writing, to the AFSRB prior to the first flight or operation of the project. The report includes committee recommendations for project operation, unsatisfactory or marginal areas or conditions, any restrictions and/or limitations that should be imposed, and any concern for lack of information, cooperation, or openness on the part of any person interviewed. It is the responsibility of the Project Manager of the project under review to provide the follow-up and closeout of any open items before the first flight or operation of the vehicle will be permitted.

FRR Committees are given a very high priority at Dryden and individuals assigned to them will be expected to place the Committee requirements ahead of their normal functions.

Review Cycle



20.0 FLIGHT OPERATIONS PHASE

The flight operations phase, as defined for this manual, consists of functions that must be performed in conjunction with every flight of a research aircraft at Dryden. These are the events that take place within a 24-hour period after the Crew Brief, and may continue for a few hours after flight start. Most of the flight preparations have been accomplished by the start of this phase, and the applicable policy contains procedural actions for conducting a safe and efficient research test flight.

21.0 CONTROL ROOM/IN-FLIGHT CONTROL

All research flights at Dryden will be positively controlled by radio, normally from one of the two control rooms located on the third floor. Other locations are sometimes used in special cases, but these two locations are generally the best flight control setups.

> The staffing and setup of the control room layout will necessarily change with each flight and project. This is one of the reasons that control room configuration and procedures are briefed at the preceding Crew Brief, and a list of required personnel is established for each mission.

A number of positions are required for every flight, regardless of any given flight or project setup. One is the flight controller, or "NASA-1/-2." This name is both the radio call sign of the control room in use, and the acronym assigned to the flight controller position. The controller is the primary communicator with the test pilot of the research aircraft. The controller assimilates information received from various monitoring stations, relays the relevant information to the pilot of the research aircraft, and in some cases to the pilot(s) of the chase aircraft or other participants in the mission. The controller may also allow other selected individuals to communicate directly with the aircraft. Exercise of this option is limited to briefed events with a predetermined communications priority plan well understood by the selected individual.

> The controller for any given flight or program is highly knowledgeable about the aircraft being tested, and proficient with operations and procedures used at Dryden and the AFFTC. The controller selected may be a project pilot on the aircraft being flown, another qualified test pilot, or an Operations Engineer assigned to the program, depending upon the risk classification of the program or particular flight to be made. In some cases, the best-qualified flight controller may be selected from the contractor's representatives. Final authority for approval regarding controller selection will be obtained in writing from the Chief, Flight Operations Directorate.

A second required position in the control room is that of the Director, Flight Operations Directorate (or his representative). He has the final authority in flight safety matters and can stop any maneuvers or flight sequences being performed, or may abort the flight in the best interests of safety.

The Project Manager, or his representative, is another control room participant. He retains full responsibility and authority for mission conduct (unless overridden by the Flight Operations Director) in all areas not involving flight safety. The aircraft pilot, as the immediate commander of the aircraft, will make the final decisions regarding the operation of the aircraft.

22.0 RAV OPERATIONS PROCEDURES

The Remotely Augmented Vehicles (RAV) Facility is considered a critical system for Remotely Piloted Research Vehicle (RPRV) flights, and for some piloted vehicle flights. It is considered just as critical a system as any physically located in the research aircraft. In many cases, flight evaluations can be made by replacing one or more onboard systems (such as flight controls) to allow very precise flight conditions or maneuvers to be flown. It is very common to combine several technologies simultaneously. RPRV and RAV type vehicles are connected to the facility through downlink and uplink systems. This permits control logic to be changed and programmed flight control inputs to be made during actual flights. Very strict procedures and policy govern setup, preparation, security, and use of the RAV Facility during research flights. This facility supports the remote augmentation of flight vehicles with three primary classes of operation.

> One class of operation, known as RAV, involves a full-scale aircraft in flight, with the pilot located within the vehicle. Pilot stick commands and vehicle state information are telemetered to the ground. These are input into control law algorithms running in the general-purpose, ground-based computer that calculates surface position commands. These commands are then uplinked to the vehicle, where the surfaces move in response, closing inner and outer augmentation loops.
>
> Another class of operation, Remote Computed Displays (RCD), involves the use of the same equipment and interface scheme. These algorithms, which reside in the ground-based computers, examine the vehicle flight path relative to the desired flight path, and determine error signals, which are then displayed to the pilot as an aid for precision maneuvering. These algorithms are often quite complex, but remain open loop, never directly controlling vehicle surfaces.

A third class of operation, involving RPRVs, may be either full or subscale. This class of operation closely resembles RAV, except the pilot is located in a fixed-based cockpit on the ground within the RAV Facility. The pilot’s cockpit instruments are driven by telemetry signals from the vehicle, and the pilot’s commands are sent to the ground computer, where control law algorithms are executed to close inner and outer vehicle augmentation loops.

In all instances, those elements of the RAV Facility involved in support of a specific vehicle are treated as an actual part of the vehicle while in flight status. Pre-flights and combined systems tests are performed, and the equipment is secured.

23.0 PILOT'S FLIGHT MANUAL

All aircraft built for military or civilian use have Flight Manuals published that contain basic operating instructions, and which detail aircraft limitations for the pilots of those vehicles. These are generally satisfactory for use at Dryden when flying aircraft in their "as-built" configuration. Many of the aircraft flown here, however, are modified to affect their flying qualities, and are flown in maneuvers or environments not intended by the manufacturer. To update the Flight Manual, we use the "Fact Sheet", which reflects any changes to configuration, limitations, or flying qualities that may be encountered.

Several different types of Pilot's Flight Manuals are available for use at Dryden because of the diversity of airplanes assigned for test and test support. The most common is the Military Flight Manual (NATOPS Manual, for Navy airplanes) provided for normal operation of military aircraft. These manuals cover systems, normal and emergency procedures, limitations, flying qualities, performance, and adverse weather procedures. The information provided is normally used for military operation of the aircraft. NASA crews use the same manuals, plus the NASA "Fact Sheet", which contains information on modifications, instrumentation, and special equipment installed in the airplane. The "Fact Sheet" also covers any special operating procedures necessary for NASA use of the airplane.

Another type of Pilot's Manual is the Federal Aviation Administration (FAA) approved Flight Manual, which is required for any certificated airplane. These FAA approved manuals range from very basic manuals for small single engine trainers, to multi-volume manuals used to describe systems and procedures on large airliners. For NASA operations these manuals are also supplemented by "Fact Sheets" to provide the necessary operating information.

Special-purpose aircraft built for NASA may or may not have a formal Flight Manual provided. In cases where none is provided, Dryden engineers and manufacturer representatives will provide the necessary information and ground school training for the pilot. The documentation and notes that result from the ground school, combined with a comprehensive Fact Sheet, make up a Pilot's Flight Manual for these aircraft. These manuals are updated in the same way as a standard Pilot's Flight Manual.

24.0 POST-FLIGHT DEBRIEFING

A debriefing is usually held immediately after every flight of a research aircraft. This gives participants an opportunity to assemble all observations, facts, and information from a mission that is still fresh in their minds. The attendees are the same individuals who were present for the Crew Brief that preceded the flight.

The debriefing covers the time period from the Crew Brief through flight preparations, actual flight, and recovery phases. The pilot, flight controller, chase pilots, and anyone with pertinent information about the flight discuss the events as they occurred, paying particular attention to discrepancies or abnormalities.

The results and information gathered at this briefing, along with the formal data analysis, are now used as the basis for planning the next flight, or series of flights. Any discrepancies noted during flight are discussed here, and decisions are made whether to include them in the aircraft's "NASA DFRC Workbook" and to generate Discrepancy Reports

25.0 SUPPORT AIRCRAFT

Support aircraft used by Dryden will generally be included in one of several categories. The first is the chase aircraft. Chase aircraft are primarily used to provide a knowledgeable observer in the direct vicinity of the research aircraft. The chase pilot can provide timely information to the pilot of the research aircraft information on its condition, position over the ground, and airspeed. Other uses for a chase aircraft include airborne photography, backup control (in the case of remotely piloted vehicles), and an extra "set of eyes" so the research pilot can concentrate more fully on the task of flying the mission, with minimum concern for air traffic. At least one “safety chase” aircraft is required for every Dryden Research Flight. A second chase aircraft may be required to provide photographic or video coverage of particular maneuvers or flight conditions. On rare occasions, such as launching payloads from a carrier aircraft, a third chase aircraft may be employed as a backup in the event one of the first two aborts.

A second category for support aircraft is that of proficiency training. The same types of aircraft used for chase are also used to maintain pilot proficiency in high-performance, fighter-type aircraft, to ensure that test pilots’ skills are maintained.

The other category of support aircraft used at Dryden is the carrier aircraft, a B-52 used to launch manned or unmanned research aircraft, or to drop test articles for parachute testing.

26.0 DEFINITIONS

Airworthiness—

The capability of an aircraft to be operated within a prescribed flight envelope, and according to prescribed procedures, in a safe manner.

Alternate Configuration—

An approved configuration that may be used interchangeably with standard or alternate configurations without going through normal approval cycles.

Controlled Aircraft—

Center Controlled—

An aircraft that meets one or more of the following criteria:

- Dryden has primary operating responsibility.
- Is, or will be, owned by, assigned to, leased by, operated by or for the Dryden Flight Research Center.
- Utilizes any Dryden facilities or personnel, with the Director, Dryden Flight Research Center, formally agreeing to assume control of the aircraft.

Non-Center Controlled—

Aircraft not meeting any controlled aircraft criteria above, which may utilize Dryden personnel or facilities under a formally approved agreement, wherein flight safety responsibility remains with the using party, rather than being assumed by the Dryden Flight Research Center. Aircraft on loan from Dryden will not be considered controlled by Dryden unless so stated by formal agreement with the Center Director.

Disturbed System—

An existing, or baseline, system that has been modified, added to, or deleted from, for a temporary time period or number of flights, with the intent of returning the system to normal within a reasonable time.

Fail-op—

A failure in a system or component that leaves the aircraft a minimum of two failures away from catastrophic loss is considered “fail-op.” In theory, the aircraft would by capable at this point of continuing the mission with essentially no noticeable degradation to the aircraft or its flying qualities. In actual fact, this is seldom the case, the usual rule for failures of this type is to cease research maneuvers and return to base.

Fail-safe—

A failure in a system or component that leaves the aircraft one failure away from catastrophic loss is considered “fail-safe.” This means that the aircraft can be safely brought back to base assuming there are no additional failures. Flying qualities may or may not be degraded depending upon the nature of the failure or the system(s) affected.

Flight-Critical Facility—

A facility, or any portion thereof, which is essential to safety and mandatory for flight operations, the failure of which is capable of resulting in a catastrophic flight accident.

Flight Operations Limits (FOL)—

FOLs are limits imposed by project management that further restrict published flight envelopes, and are often temporary in nature, depending on variations in the configuration of the affected aircraft. Many projects use Mission Rules in place of FOLs to accomplish the same purpose.

Safety and Mission Assurance Office—

An office of aircraft-oriented personnel that ensures proper elements of SR & QA are planned for and implemented on each research aircraft project, while contributing its portion to the overall Center's Aviation Safety Program.

Host Operations—

Dryden provides services to another organization which retains responsibility for airworthiness, mission success and flight safety. Services provided might include ramp, hangar and office space.

Mission Rules—

Rules that govern the conduct of flight operations for a given project. They may be generated by any involved Dryden organization but Project Management coordinates and lists these rules for presentation at Technical Briefings. They may vary from flight to flight as the situation dictates.

Plans—

1. Project Plan—

   The basic planning document which describes the overall plan for accomplishing a project. This plan may be a stand-alone document or include any or all of the following plans.

2. Project operations Plan—

   A unique plan used by the project and approved by management, which describes deviations, if any, in operation of their program from the Basic Operations Manual policies and procedures.

3. Flight Test Plan—

   A project-specific plan laying out, in as much detail as possible at any given time, their approach to accomplishing the flight test portion of the program.

4. System Safety Plan—

   The project-s proposal for how they intend to implement the formal aspects of hazard analysis, risk identification, and the procedures to be sued for the resulting risk assessment, and either the elimination, control, or acceptance of the risk.

5. R & QA Plan—

   A plan to establish Quality Assurance functions that are required to satisfy Dryden requirements for the project, and to identify in-house QA tasks and associated resource requirements to accomplish these goals.

6. Flight Plan/Flight Request—

   A specific plan for each flight, or block of flights, including the requirements for research, maneuvers required, ground rules, flight test operations, mission constraints and instrumentation required.

7. Project Research Plan—

   A plan stating the general research objectives to be accomplished during the program, long term goals, and responsibilities for accomplishing these goals.

Safety—

1. System Safety—

   A formalized and documented use of selected analyses from a broad group of available analyses to promote early identification and elimination, or control of, all hazards or risks that are present throughout the entire Flight/Facility/Ground combination that makes up the system.

2. Flight Safety—

All activities including system safety and aviation safety that allows an airborne mission to be conducted safely and within the rules and regulations of the host organization. Includes responsibility for implementation of policies and procedures, and accountability for mishaps or accidents where personnel are injured or killed or vehicle or equipment is damaged or destroyed.

3. Aviation Safety—

The operational aspects of flight safety, generally covering those flight crew elements dealing with preventative measures such as mishap prevention, mishap reporting, safety awareness and training, and safety inspections.

4. Range Safety—

That discipline which deals with the recognition, assessment, and mitigation of those hazards to personnel and property, within a given air space and the underlying terrain, which may result from operation of a flight vehicle.